

(12) UK Patent Application (19) GB (11) 2 345 344 (13) A

(43) Date of A Publication 05.07.2000

(21) Application No 9900021.8

(22) Date of Filing 04.01.1999

(71) Applicant(s)

Paper Chemical & General Ltd
(Incorporated in the United Kingdom)
Woodside Lodge, Old Vicarage Drive, Appleby,
SCUNTHORPE, DN15 0BY, United Kingdom

(72) Inventor(s)

Alan George Richards

(74) Agent and/or Address for Service

Loven & Co
Quantum House, 30 Tentercroft Street, LINCOLN,
LN5 7DB, United Kingdom

(51) INT CL⁷

G01F 1/10

(52) UK CL (Edition R)

G1R R8DB
U1S S1007 S1091

(56) Documents Cited

GB 2234824 A GB 1560273 A US 5581041 A
US 4936151 A US 4630489 A US 4195522 A
US 3792610 A

(58) Field of Search

UK CL (Edition R) G1R R8DA R8DB RBG ROC ROD
INT CL⁷ G01F 1/05 1/06 1/07 1/075 1/10 1/11 1/115

(54) Abstract Title

Apparatus for and method of measuring flowing particulate or granular materials

(57) The apparatus comprises rotary means, e.g. a paddle wheel 1, spiral blade 4 or auger with rotational axis parallel to material flow, in contact with the material e.g. cereal and rotating when the material flows through an opening, a counter for counting the number of rotations performed by the rotary means during a flow period, and processing means for calculating from the number of rotations the volume of material which has flowed in the flow period. The means can be carried on arms 6 pivoted at one end to raise/lower the means according to volume of flow, the position being taken into account for determining flow volume. The counter may be a magnetic proximity detector, capacitance or optical detector.

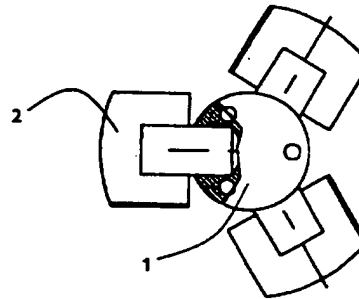


Fig 1

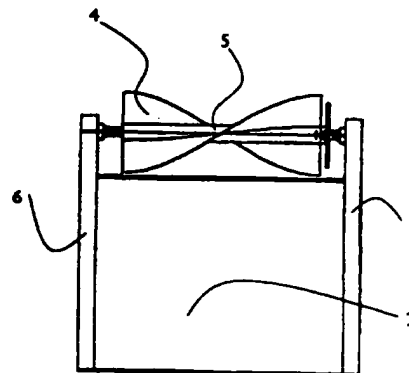


Fig 2

Best Available Copy

GB 2 345 344 A

1/2

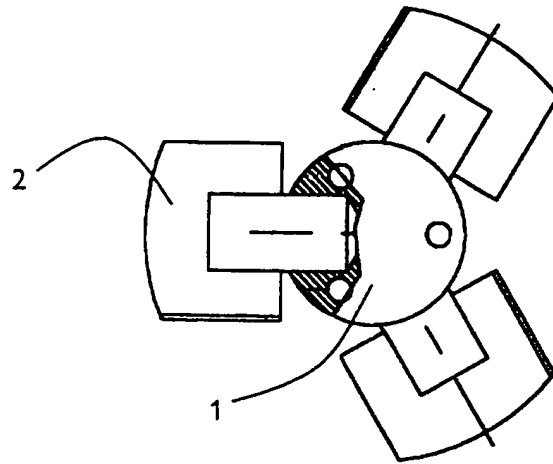


Fig 1

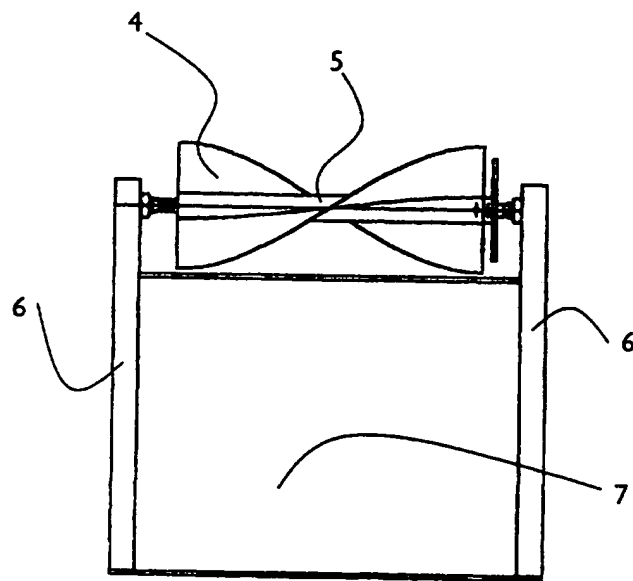


Fig 2

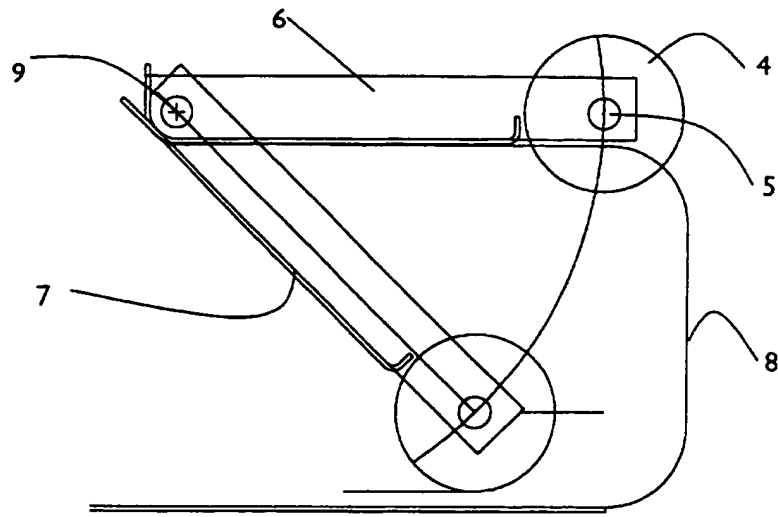


Fig 3

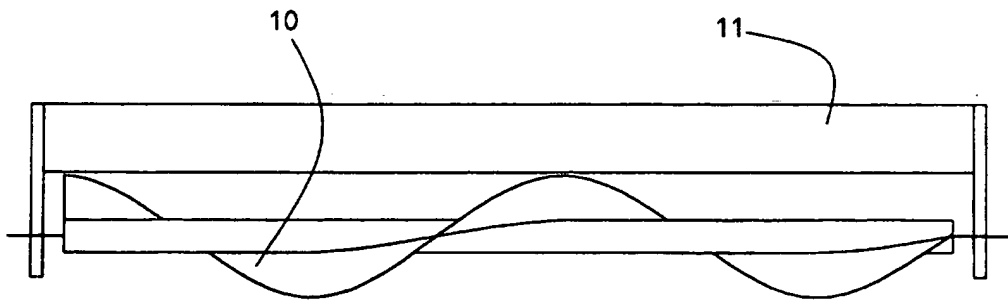


Fig 4

APPARATUS FOR AND METHOD OF MEASURING FLOWING PARTICULATE OR GRANULAR MATERIALS

Field of the Invention

This invention relates to apparatus for and a method of measuring flowing particulate or granular materials, for example cereal grains.

Background to the Invention

In the harvesting of cereal grains, for example wheat or barley, it is usual for the harvesting machine to deliver grain into trucks or trailer which then deliver it to a mill or store, either directly or via a holding silo, and for any measurement of the weight of the truck load to take place only upon final delivery. It will be seen, therefore, that the farmer does not have a precise check of the quantity of grain despatched to the mill or store, but only a record of the quantity which actually reaches there. If any grain is lost between the harvester and the mill or store, for example through theft, the farmer is not able to prove the loss, and will be paid only for the actual quantity delivered.

It is also difficult for the farmer to monitor precisely the yields from individual fields, for example to determine the effect of different crop management techniques, since delivered loads may not all relate to single fields or other small units.

It is desirable, therefore, to be able to measure the weight of grain delivered from the harvester, or that delivered to the holding silo.

It is known to install load cells on the chassis of a truck or trailer to enable the weight of the load to be measured. However, this requires fairly extensive modification of the vehicle, and is therefore too costly to permit its widespread adoption at the farm or harvest level.

It has now been found that by measuring the grain when it is flowing, either when being delivered by an auger or other screw arrangement, or when being tipped from a truck, an accurate measurement can be obtained without the need for very expensive modifications.

Summary of the Invention

According to the invention, apparatus for measuring the quantity of a flowing particulate or granular material passing through a flow channel, comprising means for measuring movement of the bulk material, for example rotary means in contact with

the material and rotating when the material flows through an opening, a counter for counting the number of rotations performed by the rotary means during a flow period, and processing means for calculating from the number of rotations the volume of material which has flowed in the flow period.

5 The rotary means may be a paddle or vane device located adjacent to the opening so as to rotate in consequence of the movement of the material therethrough, or it may be an auger or Archimedes Screw device for causing the material to flow in a flow conduit, for example the delivery screw in a combine harvester for delivering accumulated grain from an internal hopper to a collection truck or the like. In the case of
10 an auger or screw conveyor, the load on the drive motor for the screw may be measured to determine when the flow conduit is empty, permitting the revolutions of the screw to be ignored when the conveyor is running empty.

 In the case where the rotary means is a paddle device located adjacent to an outlet in a tipping truck body, the position of the paddle relative to the flowing material
15 can be varied according to the size of the outlet, where this is also variable, the processing means taking account of the position of the paddle device in determining the quantity of material passing the paddle; as the size of the outlet is increased, the flow rate will increase, and thus the unit quantity (volume) of grain per revolution of the paddle. It will be possible, for example, to mount the paddle device on a pivoting arm
20 and to calibrate the processing means to adjust the amount per revolution of the paddle device according to the degree of rotation of the pivoting arm.

 The processing means may also be provided with means for entering the specific weight (weight per unit volume) of the particular material, so that the processing means can calculate the total weight of material delivered in a monitored period, for example
25 during emptying of a tipped truck, or during operation of an auger or other screw conveyor. The means for entering the specific weight may comprise a keypad for the manual entry of the value, but it may alternatively comprise means for determining the weight of a standard volume of the grain. This may be achieved, in the case of a tipper truck, by incorporating in the body a standard sampling container to collect a sample of
30 the grain in a known volume, means being provided for measuring the change in weight between the empty and full states of the container. The sampling and weighing may be

carried out automatically during the tipping operation, the result being delivered to the processing means to permit the delivered weight to be calculated as the discharge of the grain finishes.

Although mention is made of a paddle device for measuring the flow of the material, it will be appreciated that the device may take any of a number of different forms. For example, the device may comprise one or more thin blades mounted in spiral form around a longitudinal axle within the flowing material so that as flow occurs parallel to the axle, the blades are caused to rotate, thereby rotating the axle.

The revolutions performed by the axle of the rotary means, whether a paddle wheel, auger, or spiral blade device, may be measured in any of a number of different ways. For example, the axle may carry a magnet whose proximity to a detector (for example a coil) once in each rotation of the axle causes an electrical signal pulse to be generated, the pulses being counted by the processing means. Alternatively, measurement may be by a similar arrangement detecting changes in capacitance, or by a simple shutter arrangement connected to the axle and opening an optical path between a light source (for example an light-emitting diode or LED) and a detector (for example a phototransistor) once (or more, for greater precision) in each rotation of the axle. It will be appreciated that other ways of detecting rotations of an axle or the like are well-known and may be substituted for the examples set out hereinbefore.

The invention also provides a method of measuring the quantity of a flowing particulate or granular material passing through a flow channel, comprising locating a rotary means in contact with the material such that said rotary means rotates when the material flows through an opening, counting the number of rotations performed by the rotary means during a flow period, and calculating from the number of rotations the volume of material which has flowed in the flow period.

The device of the invention may be installed in existing machinery, such as a combine harvester or a delivery truck or trailer, simply and at low cost, as well as being incorporated into new machinery.

Although the invention is described herein in relation to the measurement of grain, it will be understood that the apparatus and method are equally applicable to

other free-flowing powdered and granular solids whose value is such as to require accurate measurement of bulk quantities.

Brief Description of the Illustrated Embodiments

In the drawings, which illustrate exemplary embodiments of the invention:

5 Figure 1 is an end elevation, partially sectioned, of a paddle device for use in the apparatus of the invention;

 Figure 2 is a top plan view of a screw device as an alternative to the paddle device of Figure 1;

 Figure 3 is a side elevation of the device of Figure 2; and

10 Figure 4 is a side elevation of an alternative screw device.

Detailed Description of the Illustrated Embodiments

Referring first to Figure 1, the device comprises a hub 1 with three blades 2 mounted therein and each angled to the axis of rotation of the hub 1 so as to be caused to rotate as the grain moves in a direction parallel to the axis of rotation, passing over
15 at least a part of the blade submerged therein. In use, the device will be mounted just above the moving stream of grain being discharged from a tipping truck, adjacent to the discharge outlet in the end of the truck body. Rotation of the hub of the device is monitored by a detector mounted on or adjacent to the shaft of the hub, for example a magnetic proximity device. It may be desirable to alter the pitch of the blades 2, and
20 for this reason they are rotatably mounted in the hub. While an angle of 45° may be suitable for most grain applications, other types of materials may require different angles to ensure the best turning effect imparted to the device from the flowing material.

 Figures 2 and 3 show an alternative arrangement in which a screw 4 is mounted on a shaft 5 mounted between two arms 6 of a support member 7, the shaft 5 extending
25 parallel to the direction of flow of the grain, in use. The support member 7 is pivotally mounted at a position above the flow opening 8 in the tipping truck body (Figure 3) so as to be able to pivot across the face of the opening to allow for reduced flow rates when the level in the tipping body has dropped to below the level of the top of the opening 8. The shaft 5 carries means (not shown) for signalling each revolution of the
30 shaft to a central processing means, and the support member pivot 9 carries means for signalling the angle of rotation of the support body. When the flow through the open-

ing 8 is such as to occupy the whole cross-section of the opening, each revolution of the screw 4 represents a known volume of grain derivable from the cross-sectional area of the opening, but when the level drops below the top of the opening, the screw pivots downwards to follow the flow of grain, and each revolution then represents a smaller
5 volume, proportional to the angle the support member 7 drops below its uppermost position as shown in Figure 3. The angle signalled to the central processing means is used to compensate for the reduced flow and so still give an accurate representation of the volumetric flow per revolution of the screw 4.

Figure 4 shows another type of screw detector device, in which the screw 10 is
10 located in a fixed bracket 11. The screw 10 has a shallower pitch than that shown in Figures 2 and 3. The bracket 11 is mounted so that the screw 10 is positioned within the flowing stream of grain and is rotated by it. The rotations of the screw 10 are signalled back to the central processing means in any convenient way, for example by a magnetic, capacitive or optical sensor associated with the shaft.

15 By combining the volumetric measurement obtained by relating the number of revolutions of the detector to the size of flow channel or opening with a measurement of specific weight (i.e. weight per unit volume) for the material being measured, the total weight of the load can be obtained. For grain, the specific weight will vary not only for different grains, but also for the same type of grain grown in different conditions, for
20 example in a different field, or harvested at a different time from the same field. The present invention will permit the farmer to record exactly the weight of grain harvested per storage tank load of the crop gatherer, or a container into which a discharge is made, which in turn will permit an accurate auditing of the grain stored on the farm and subsequently delivered to a merchant or external store.

CLAIMS

1. Apparatus for measuring the quantity of a flowing particulate or granular material passing through a flow channel, comprising rotary means in contact with the material and rotating when the material flows through an opening, a counter for
5 counting the number of rotations performed by the rotary means during a flow period, and processing means for calculating from the number of rotations the volume of material which has flowed in the flow period.
2. Apparatus according to Claim 1, wherein the rotary means is a paddle or vane device located adjacent to the opening so as to rotate in consequence of the
10 movement of the material therethrough.
3. Apparatus according to Claim 1, wherein the rotary means is an auger or Archimedes Screw device for causing the material to flow in a flow conduit
4. Apparatus according to Claim 3, comprising means for measuring the load on the drive motor for the screw to determine when the flow conduit is empty.
- 15 5. Apparatus according to Claim 2, comprising means for varying the position of the paddle relative to the flowing material according to the variable size of the outlet, the processing means being arranged to take account of the position of the paddle device in determining the quantity of material passing the paddle.
6. Apparatus according to Claim 5, wherein the paddle device is mounted
20 on a pivoting arm and the processing means is arranged to adjust the amount per revolution of the paddle device according to the degree of rotation of the pivoting arm.
7. Apparatus according to any preceding claim, wherein the processing means is provided with means for entering the specific weight (weight per unit volume) of the particular material, and the processing means is arranged to calculate the total
25 weight of material delivered in a monitored period
8. Apparatus according to Claim 7, wherein the means for entering the specific weight comprises a keypad for the manual entry of the value.
9. Apparatus according to Claim 7, wherein said means for entering the specific weight comprises means for determining the weight of a standard volume of the
30 grain.

10. Apparatus according to Claim 9, wherein the means for determining the weight of a standard volume comprises a standard sampling container to collect a sample of the moving grain in a known volume, means being provided for measuring the change in weight between the empty and full states of the container.

5 11. Apparatus according to any preceding claim, wherein the rotary means is carried by an axle which carries a magnet and a detector is provided adjacent to the axle whereby the proximity of the magnet to the detector once in each rotation of the axle causes an electrical signal pulse to be generated, the pulses being counted by the processing means.

10 12. Apparatus according to any of Claims 1 to 10, wherein the rotary means is carried by an axle which carries a shutter arrangement opening an optical path between a light source and a detector at least once in each rotation of the axle.

13. A method of measuring the quantity of a flowing particulate or granular material passing through a flow channel, comprising locating a rotary means in contact
15 with the material such that said rotary means rotates when the material flows through an opening, counting the number of rotations performed by the rotary means during a flow period, and calculating from the number of rotations the volume of material which has flowed in the flow period.

14. Apparatus for measuring the quantity of a flowing particulate or granular
20 material passing through a flow channel, substantially as described with reference to, or as shown in, any of the drawings.

15. A method of measuring the quantity of a flowing particulate or granular material passing through a flow channel, substantially as described with reference to any of the drawings.



INVESTOR IN PEOPLE

Application No: GB 9900021.8
Claims searched: 1-15

Examiner: Roger Binding
Date of search: 3 April 2000

Patents Act 1977 Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): G1R (RBDA, RBDB, RBG, RQC, RQD)

Int Cl (Ed.7): G01F 1/05, 1/06, 1/07, 1/075, 1/10, 1/11, 1/115

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
Y	GB 2234824 A (KIMMON MANUFACTURING)	11
X	GB 1560273 A (KK HOSOKAWA FUNTAD)	1, 2, 13
X, Y	US 5581041 A (BOUCHILLON)	X - 1, 3, 13 Y - 11
Y	US 4936151 A (TOKIO)	12
X, Y	US 4630489 A (FISHER)	X - 1, 2, 11, 13 Y - 12
Y	US 4195522 A (ANDERSON)	12
Y	US 3792610 A (KOUNTANIS)	12

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

☒ **BLACK BORDERS**

☒ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**

☒ **FADED TEXT OR DRAWING**

☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**

☐ **SKEWED/SLANTED IMAGES**

☒ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**

☐ **GRAY SCALE DOCUMENTS**

☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**

☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**

☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.